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(54) **Pole-to-pole connection of an electric generator and method for manufacturing the same**

(57) The pole-to-pole connection (3, 4, 5) of an electric generator comprises two curved bars (11) connecting the poles (2a, 2b, 2c, 2d) of an electric generator and an expansion joint in-between. The expansion joint comprises

a U-shaped element (12) cut out from a single plate and connected to the curved bars (11). The present invention also refers to a method for manufacturing the pole-to-pole connection.

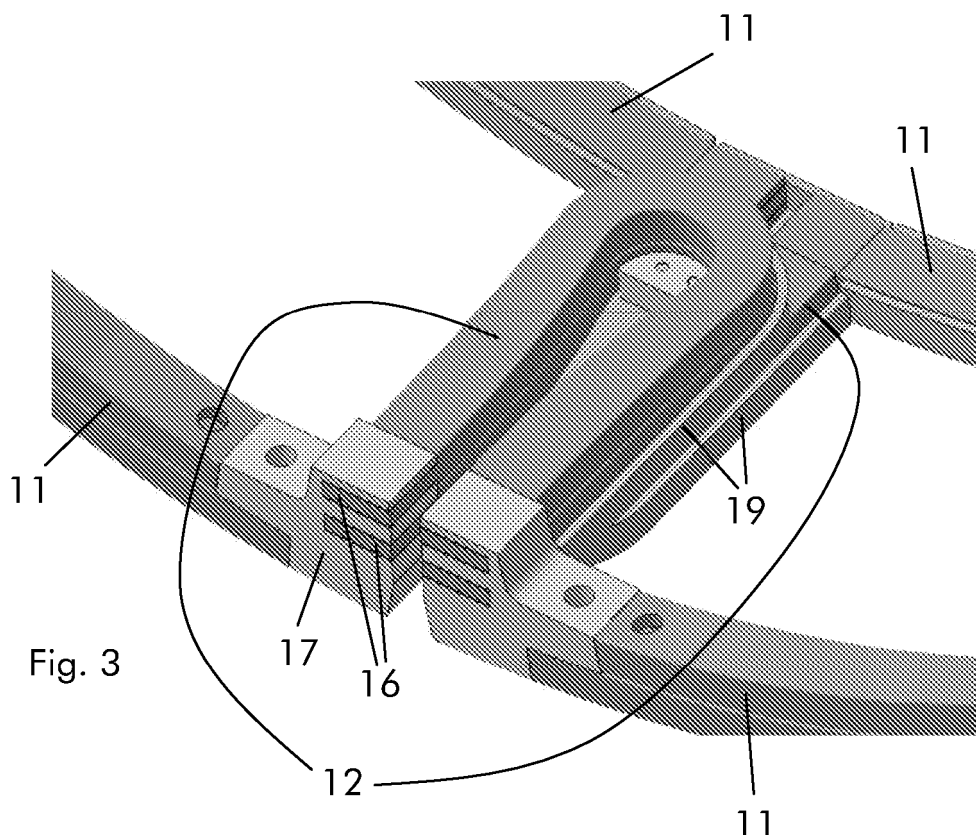


Fig. 3

Description

TECHNICAL FIELD

[0001] The present invention relates to a pole-to-pole connection of an electric generator and a method for manufacturing the same.

BACKGROUND OF THE INVENTION

[0002] Electric generators are known to comprise a rotor that carries windings defining two or more poles; figure 1 shows an example of a rotor 1 having four poles 2a-2d.

[0003] The four poles 2a-2d are connected each other via pole-to-pole connections 3, 4, 5.

[0004] In particular, a first pole-to-pole connection 3 connects two adjacent poles 2a, 2b; a second pole-to-pole connection 4 connects two opposite poles 2a, 2c, and a third pole-to-pole connection 5 connects two further adjacent poles 2c, 2d.

[0005] Typically, for symmetry reasons, connection 4 is made of two conductors, each having half the thickness of those conductors defining the connections 3 and 5.

[0006] Pole-to-pole connections are defined by curved bars that extend around the rotor 1 and, during operation, must withstand high centrifugal forces and thermal loads that make them to deform.

[0007] For these reasons, the curved bars are provided with expansion joints that let deformations be adsorbed without causing dangerous stresses within them.

[0008] In a first traditional embodiment expansion joints are made of U-shaped elements made of three copper blocks brazed together.

[0009] Nevertheless manufacturing of these expansion joints is very time-consuming, since the blocks must be separately manufactured and then must be brazed together while avoiding any copper decrease of properties or recrystallization.

[0010] In a second traditional embodiment expansion joints are made of copper brackets brazed to the curved bars and a set of overlaying copper lamellas withheld within the brackets.

[0011] Nevertheless for large machines a large number of overlaying lamellas is required; this increases the stiffness of the pole-to-pole connections and, in some cases, could reduce the pole-to-pole connection lifetime.

[0012] US 5,065,059 discloses a pole-to-pole connection for generators comprising U-shaped elements; the U-shaped elements are machined from high conductive copper.

[0013] Manufacturing of U-shaped elements by traditional methods induces high residual stresses into them that reduce the U-shaped element lifetime.

SUMMARY OF THE INVENTION

[0014] The technical aim of the present invention is therefore to provide a pole-to-pole connection and a

method for its manufacturing by which the said problems of the known art are eliminated.

[0015] Within the scope of this technical aim, an aspect of the invention is to provide a pole-to-pole connection having expansion joints that can be manufactured in a short time and do not require manufacturing operations that could impair their mechanical properties.

[0016] Another aspect of the invention is to provide a pole-to-pole connection having expansion joints that may have the required flexibility for all generator sizes, such that an increase of the pole-to-pole connection lifetime, in particular for large generators, is achieved.

[0017] A further aspect of the present invention is to provide a pole-to-pole connection having U-shaped elements in which, during manufacturing, only very limited residual stresses are induced, such that their lifetime is increased.

[0018] Another aspect of the invention is to provide a method that can be implemented in a short time, without impairing the U-shaped elements and that induces only very limited residual stresses into the finished U-shaped elements.

[0019] The technical aim, together with these and further aspects, are attained according to the invention by providing a pole-to-pole connection in accordance with the accompanying claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] Further characteristics and advantages of the invention will be more apparent from the description of a preferred but non-exclusive embodiment of the pole-to-pole connection and method according to the invention, illustrated by way of non-limiting example in the accompanying drawings, in which:

Figure 1 is a schematic view of a four pole rotor; Figure 2 in a perspective view of pole-to-pole connections of the four pole generator of figure 1; Figure 3 is a perspective view of two overlapping U-shaped elements of a pole-to-pole connection; and Figure 4 is a top view of two overlapping U-shaped elements of a pole-to-pole connection.

DETAILED DESCRIPTION OF THE INVENTION

[0021] With reference to the figures, these show pole-to-pole connections of an electric generator each comprising two or more curved bars 11 connecting the poles of an electric generator and expansion joints 12 in-between.

[0022] In particular, figure 2 shows pole-to-pole connections between four poles of an electric generator being the electric generator of figure 1.

[0023] Consequently, figure 2 shows four curved bars 11 with four expansion joints 12 that define the pole-to-pole connection 4, two curved bars 11 with an expansion joint 12 defining the pole-to-pole connection 3 and two

further curved bars 11 with an expansion joint 12 defining the pole-to-pole connection 5.

[0024] For symmetry reasons, the pole-to-pole connection 4 is made of four bars having half the thickness of those bars defining the pole-to-pole connections 3 and 5.

[0025] Alternatively, when bars having the same profile (and thickness) are used, connections 3 and 5 are made of overlaying bars and the total number of bars in each connection 3, 4, 5 is four.

[0026] Each expansion joint 12 comprises a U-shaped element cut out to the required final shape from a single plate and connected to the curved bars 11.

[0027] This lets further manufacturing operations such as for example bending be avoided.

[0028] In particular, the jaws 13 of the U-shaped elements 12 are not parallel, i.e. their borders in a top view (as shown in figure 4) are not parallel.

[0029] In addition, the thickness of the U-shaped element 12 in the plane containing it (being the plane of figure 4) is not constant; in particular the thickness at the curved region 15 is smaller than the thickness at the jaws 13.

[0030] The thickness of the U-shaped elements 12 in a plane perpendicular to that plane containing the U-shaped element 12 is constant; this lets the U-shaped elements rest one over the other.

[0031] The jaw ends 16 of each U-shaped element are brazed to the curved bars 11 typically via brackets 17.

[0032] In particular, figure 2 shows pole-to-pole connections 3-5 between the four poles of a four pole generator.

[0033] In this embodiment, the curved bars 11 defining the pole-to-pole connections 3, 4, 5 extend along two parallel spaced apart circumferences 18a, 18b around the rotor (only the axis 23 of the rotor is shown in figure 2).

[0034] In this respect the pole-to-pole connection 4 extends along a first circumference 18a and the pole-to-pole connections 3 and 5 extend along sectors of a second circumference 18b spaced apart from the first circumference 18a.

[0035] The U-shaped elements 12 of each pole-to-pole connection 3, 4, 5 axially extend (i.e. parallel to the rotor axis 23) towards the other circumference; for example a U-shaped element of a pole-to-pole connection extending along circumference 18a axially extends towards circumference 18b.

[0036] In particular, the U-shaped elements 12 that extend from different circumferences 18a and 18b have the same circumferential position and overlap one another.

[0037] This lets the U-shaped elements have the greatest length possible for the available space (to reduce their stress).

[0038] In addition, an insulating layer 19 is provided between the overlapping U-shaped elements 12 to avoid short circuits.

[0039] The insulating layer 19 comprises a cooling through hole 20.

[0040] The present invention also refers to a method for manufacturing pole-to-pole connections of an electric generator.

[0041] The method consists in cutting out to the required final shape a U-shaped element from a single plate and connecting it (for example by brazing) to the curved bars 11 at their jaws 13.

[0042] Advantageously, during brazing, the U-shaped element is cooled; this lets the mechanical properties of the U-shaped element be safeguarded.

[0043] Since the U-shaped elements are cut out from a single plate element and are not bent, i.e. they are cut out to the required final U-shape, manufacturing is fast and only very limited residual stresses are induced into them.

[0044] Naturally the features described may be independently provided from one another.

[0045] In practice the materials used and the dimensions can be chosen according to requirements.

REFERENCE NUMBERS

[0046]

- 1 rotor
- 2a, 2b, 2c, 2d poles
- 3, 4, 5 pole-to-pole connection
- 11 curved bar
- 12 U-shaped element
- 13 jaw
- 15 curved region of 12
- 16 jaw end
- 17 bracket
- 18a, 18b circumference
- 19 insulating layer
- 20 through hole of 19
- 23 rotor axis

Claims

1. Pole-to-pole connection (3, 4, 5) of an electric generator comprising at least two curved bars (11) connecting the poles (2a, 2b, 2c, 2d) of an electric generator and comprising at least an expansion joint in-between, **characterised in that** each expansion joint comprises a U-shaped element (12) cut out to the required final shape from a single plate and connected to the curved bars (11).
2. Pole-to-pole connection (3, 4, 5) as claimed in claim 1, **characterised in that** jaws (13) of the U-shaped element (12) are not parallel.
3. Pole-to-pole connection (3, 4, 5) as claimed in claim 1, **characterised in that** the thickness of the U-shaped element (12) in a plane containing the same U-shaped element (12) is not constant.

4. Pole-to-pole connection (3, 4, 5) as claimed in claim 3, **characterised in that** the thickness at a curved region (15) of the U-shaped element (12) is smaller than the thickness at its jaws (13). 5
5. Pole-to-pole connection (3, 4, 5) as claimed in claim 4, **characterised in that** the thickness of the U-shaped element (12) in a plane perpendicular to that plane containing the U-shaped element (12) is constant. 10
6. Pole-to-pole connection (3, 4, 5) as claimed in claim 5, **characterised in that** jaw ends of the U-shaped elements (12) are connected to the curved bars (11). 15
7. Pole-to-pole connection (3, 4, 5) as claimed in claim 6, **characterised by** extending along a circumference (18a) and by facing at least a further pole-to-pole connection extending along a parallel spaced apart circumference (18b), wherein the U-shaped elements (12) of a pole-to-pole connection extending along a circumference (18a, 18b) axially extend towards the other circumference (18b, 18a). 20
8. Pole-to-pole connection (3, 4, 5) as claimed in claim 7, **characterised in that** U-shaped elements (12) that extend from different circumferences (18a, 18b) have the same circumferential position and overlap one another. 25
30
9. Pole-to-pole connection (3, 4, 5) as claimed in claim 8, **characterised by** comprising an insulating layer (19) between the overlapping U-shaped elements (12). 35
10. Pole-to-pole connection (3, 4, 5) as claimed in claim 9, **characterised in that** the insulating layer (19) comprises a cooling through hole (20). 40
11. Method for manufacturing a pole-to-pole connection (3, 4, 5) of an electric generator comprising at least two curved bars (11) connecting the poles (2a, 2b, 2c, 2d) of an electric generator and comprising at least an expansion joint in-between, **characterised in that** the expansion joint comprises a U-shaped element (12) cut out to the required final shape from a single plate and connected to the curved bars (11). 45
12. Method according to claim 11, **characterised by** connecting the U-shaped element (12) to the curved bars (11) at the jaws (13). 50
13. Method according to claim 12, **characterised in that** connection of the U-shaped element (12) to the curved bars (11) is made by brazing, and **in that**, during brazing, the U-shaped element is cooled. 55

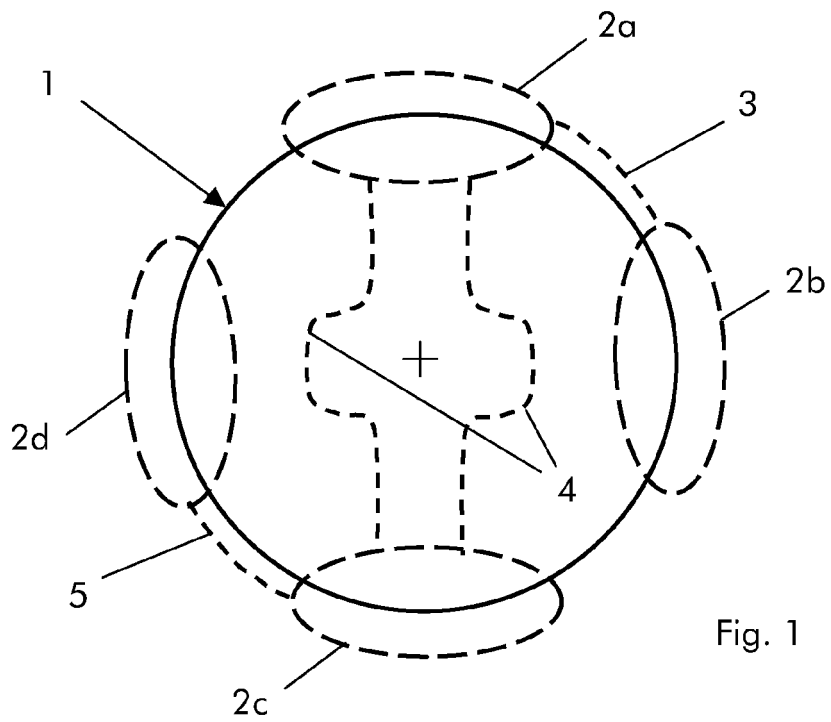


Fig. 1

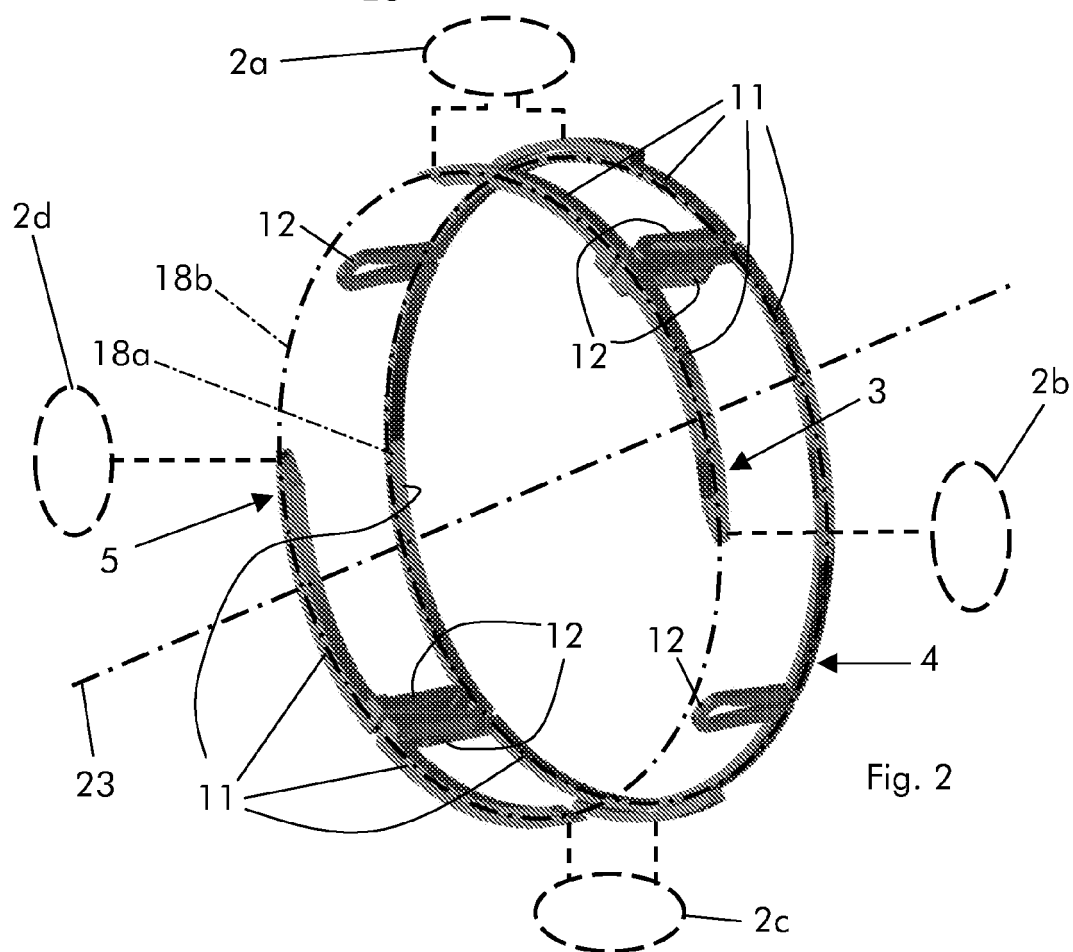
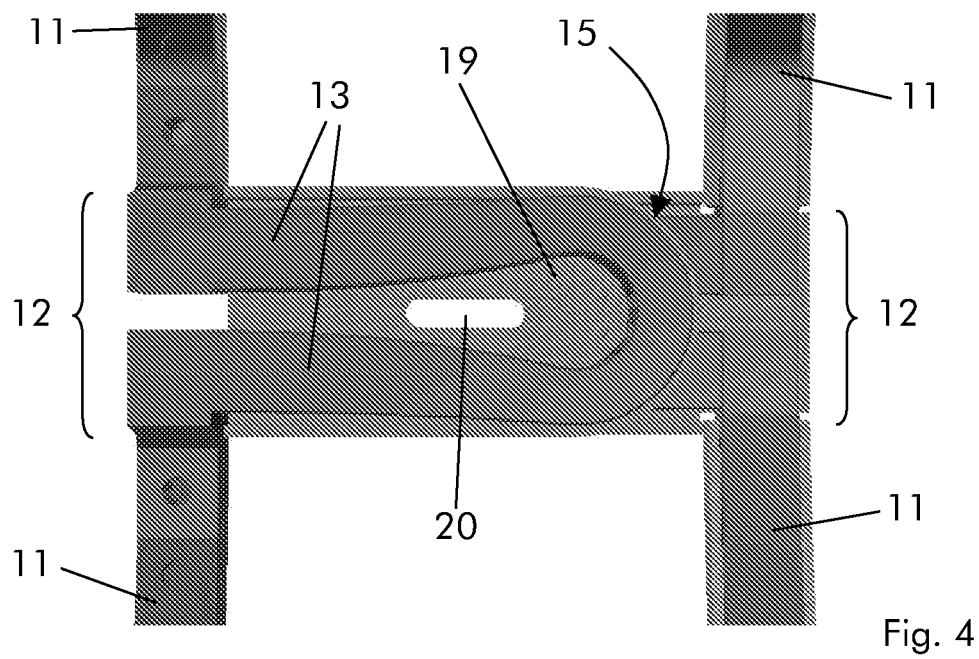
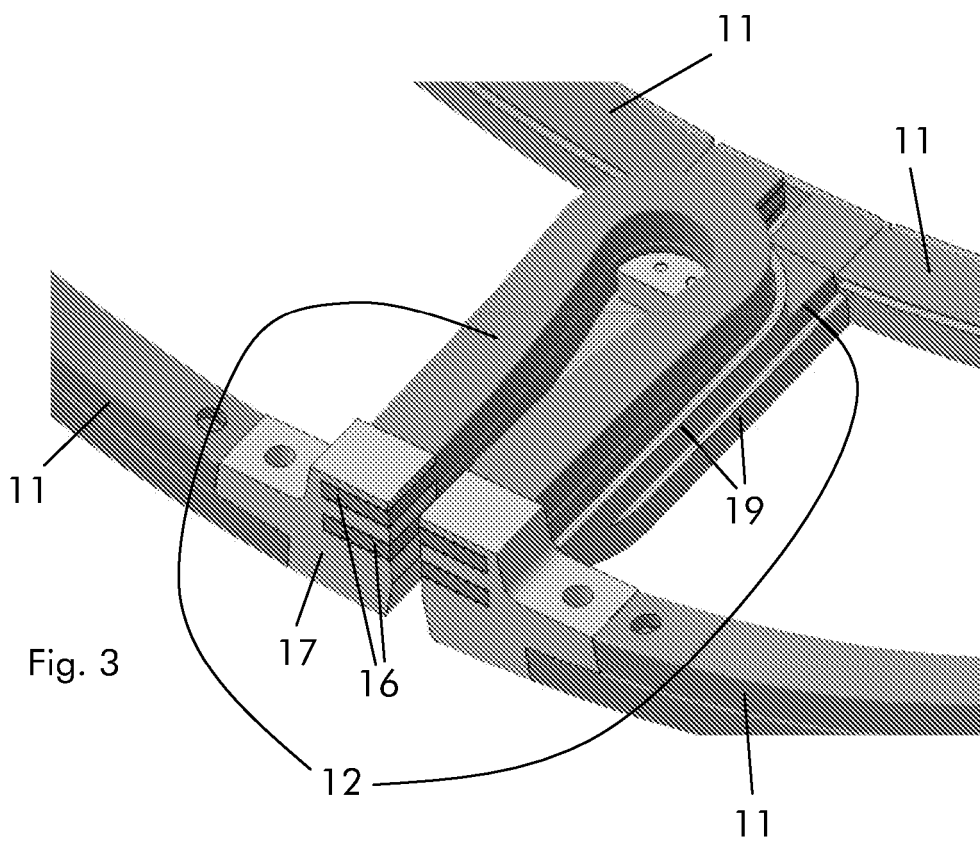


Fig. 2





EUROPEAN SEARCH REPORT

Application Number
EP 09 46 1518

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2005/285469 A1 (SHORE DAVID [US] ET AL) 29 December 2005 (2005-12-29)	1-3, 11-13	INV. H02K3/12
Y	* paragraphs [0001] - [0008], [0010] - [0015], [0026] - [0050]; figures 1,3,5,8 *	4-7	H02K3/51
Y	----- US 6 930 434 B1 (SPENCER CRAIG MICHAEL [US] ET AL) 16 August 2005 (2005-08-16) * column 5, lines 16-21; figures * -----	4-7	
			TECHNICAL FIELDS SEARCHED (IPC)
			H02K
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 6 May 2010	Examiner Mayer-Martin, E
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 09 46 1518

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The members are as contained in the European Patent Office EDP file on
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06-05-2010

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2005285469	A1	29-12-2005	NONE

US 6930434	B1	16-08-2005	NONE

REFERENCES CITED IN THE DESCRIPTION

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